Solubility

Not all ionic compounds dissolve!

Instead of doing experiments all the time to see which ones will dissolve, we use <u>The solubility rules.</u>

Solubility Rules

1. **All nitrates (NO_3^-) are soluble.**
2. **All ammonium (NH_4^+) or alkali (Li^+, Na^+, K^+, Rb^+, Cs^+, Fr^+) compounds are soluble.**
3. **All carbonates (CO_3^{2-}), phosphates (PO_4^{3-}) and hydroxides (OH^-) are insoluble except with the cations in Rule #2.**
4. **All chlorides (Cl^-), bromides (Br^-), and iodides (I^-), are soluble except with Ag^+, Pb^{2+}, or Hg^+.**
5. **All sulphates (SO_4^{2-}) are soluble except with Ca^{2+}, Sr^{2+}, Ba^{2+}, Ra^{2+}, Pb^{2+},**

Practice

Which of the following are soluble in water?

1. **$SrSO_4$**
2. **$NaNO_3$**
3. **$PbCl_2$**

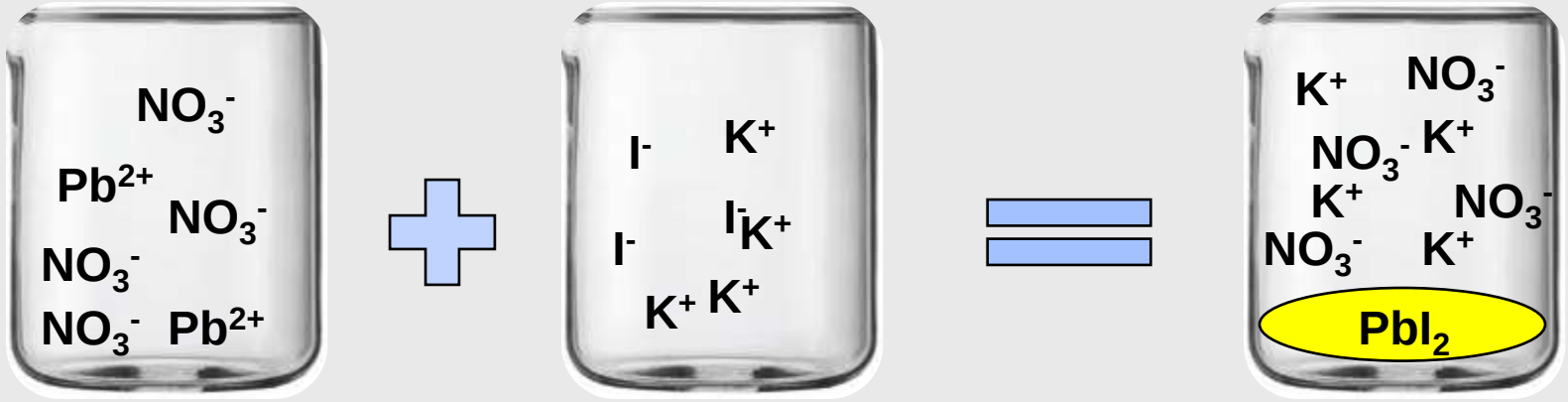
Predict the products of the following reaction: (if no solid precipitate is formed, there is no rxn)

$Pb(NO_3)_2(aq) + KI\ (aq) \rightarrow$

$Pb(NO_3)_2(aq) + 2KI\ (aq) \rightarrow PbI_2(s) + 2KNO_3\ (aq)$

We know it is a solid precipitate because it is insoluble according to the solubility rules.

View of the Rxn Ions



Because K^+ and NO_3^- remain dissolved, they are called spectator ions and are not included in the net ionic equation.

<u>Net Ionic Equation</u>

$Pb^{2+}(aq) + 2I^-(aq) \rightarrow PbI_2(s)$

Solubility Practice

Which are soluble

KCl

NH_4NO_3

AgCl

$CaSO_4$

Li_2SO_4

Precipitation Reactions

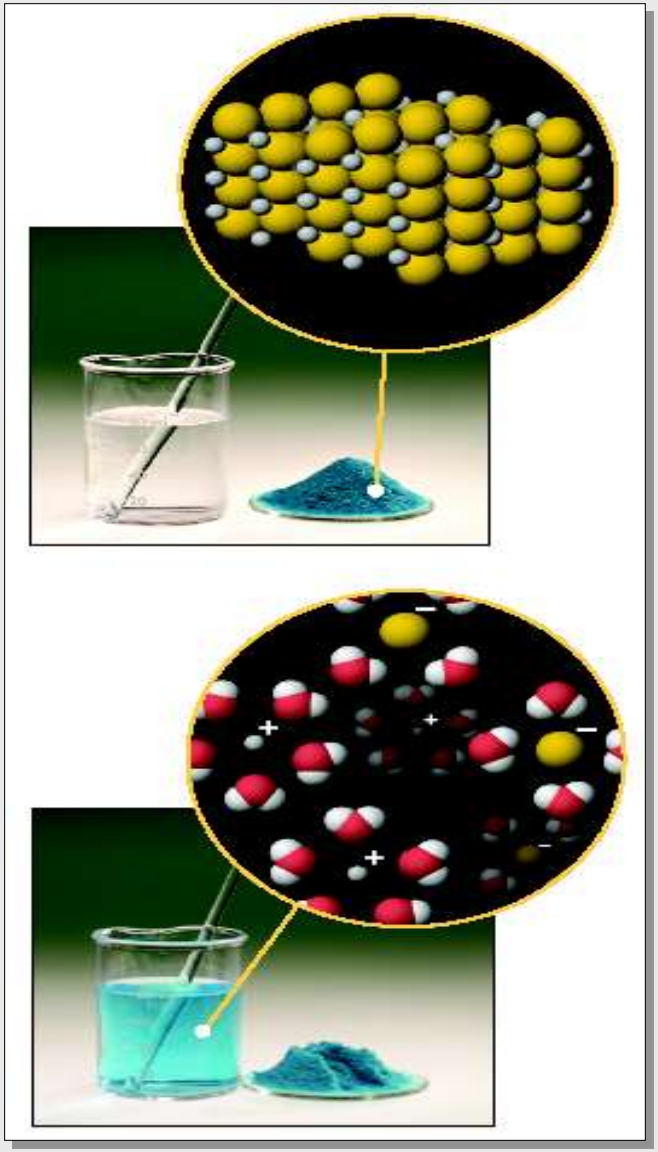
When a solid doesn't dissolve it is called insoluble.

A solid that forms when two solutions are mixed is called a precipitate.

Denoted as (s) in a chemical equations

Some Definitions

A solution is formed when a Solvent and Solute are mixed.



PARTS OF SOLUTIONS

SOLUTE –part of a solution that is being dissolved (usually the lesser amount)

SOLVENT –part of a solution that dissolves the solute (usually the greater amount)

Solute + Solvent = Solution

Definitions

Solutions can be saturated or unsaturated.

__Saturated__ solution contain the maximum amount of solute.

An __unsaturated__ solution contains less solute than a solvent can hold at a particular temp.

Definitions

<u>SUPERSATURATED SOLUTIONS</u>
contain more solute than a solvent can hold

They are unstable. The super saturation is only temporary, and usually accomplished in one of two ways:

To Make a Supersaturated Solution

1. **Warm the solvent so that it will dissolve more, then cool the solution**
2. **Evaporate some of the solvent carefully so that the solute does not solidify and come out of solution.**

Supersaturated Rock Candy

This supersaturated sucrose and food coloring solution uses a "seed" crystal to make…

Crystal Rock candy

Bell Work
27-Feb-2014

Based on the reactants below, what is the precipitate and balance?

$Ca(NO_3)_2(aq) + Na_3PO_4(aq) \rightarrow$

Agenda:

- **Polarity**
- **Molarity**

Objective: You will UNDERSTAND how to calculate molarity, and APPLY your knowledge to making solutions

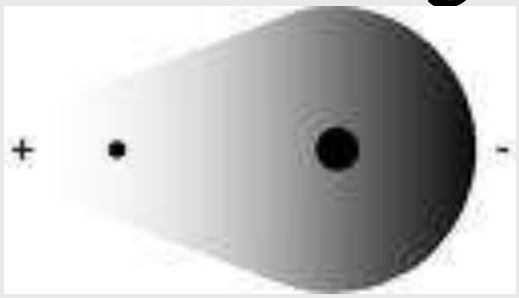
Factors affecting solubility

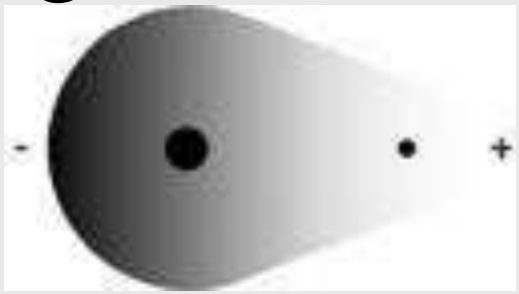
1. Heat increases solubility in most liquids

   * solubility of gases are greater in cold water than hot.

2. True: the solubility of gas increases w/ increasing pressure

Factors affecting solubility





3. Polar molecules will only dissolve in Polar molecules

Non- polar molecules will only dissolve in non-polar molecules

“like dissolves like”

RATE OF DISSOLUTION

Several Factor determine the rate a substance dissolves

1. **Agitation** **helps a solute to dissolve because it brings fresh solvent into contact w/ the solute**
2. **A greater Surface area of solute is exposed to the colliding water molecules**

RATE OF DISSOLUTION

Several Factor determine the rate a substance dissolves

3. Energy also influences the rate at which a substance dissolves. The higher energy leads to increased frequency and number of the collision of water molecules w/ crystal surfaces

Question

A solution is made up of 25 grams of cyclohexane (non-polar) and 7 grams of acetonitrile (polar).

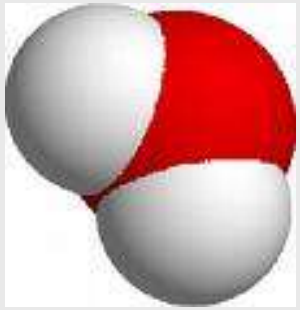
What is the solute ?

What is the solvent?

Would you expect the solvent to readily mix with the solute?

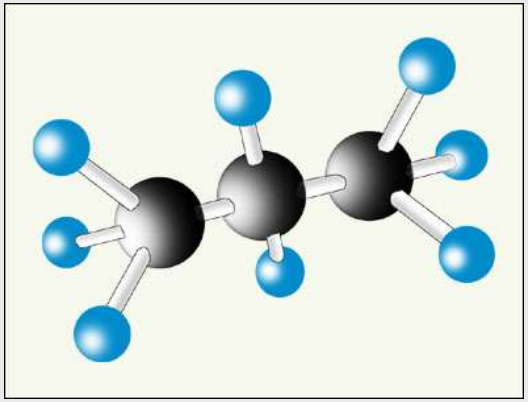
Polarity

"polar" molecules: An uneven distribution of electron density. Ex. water H_2O



“non polar” molecules: an even distribution of electron density.

Ex. Oil, propane, etc.



http://www.youtube.com/watch?v=PVL24HAesnc

http://www.youtube.com/watch?v=LKAjTE7B2x0&feature=related

BELL WORK
5-Apil-17

What is a solution?

Try explaining it as if you were writing to a friend not to Mr. Golden

What is an ionic compound?

Solution Quick Review

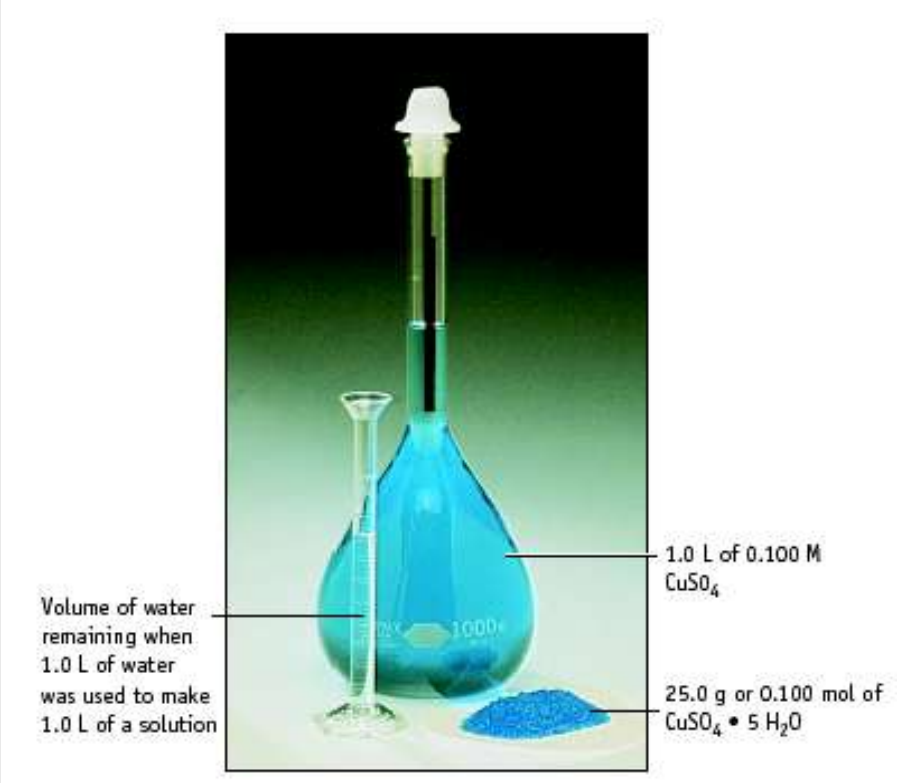
http://www.youtube.com/watch?v=9h2f1Bjr0p4

Concentration of a solution

The amount of solute in a solution is given by its concentration.

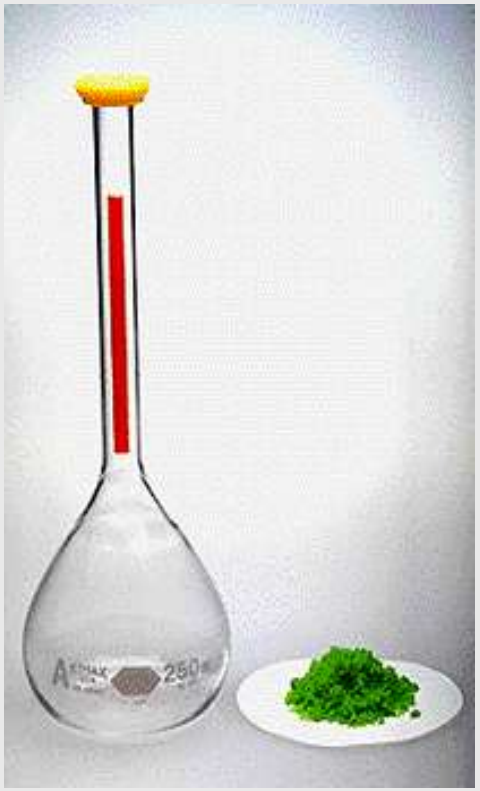
$$\textbf{Molarity (M)} = \frac{\textbf{moles solute}}{\textbf{liters of solution}}$$

1.0 L of water was used to make 1.0 L of solution. Notice the water left over.



Practice

Dissolve 5.00 g of $NiCl_2$ in enough water to make 250 mL of solution. Calculate the Molarity.



Dissolve 5.00 g of $NiCl_2$ in enough water to make 250 mL of solution. Calculate the Molarity.

Step 1: Calc. moles of $NiCl_2$

$$5.00\ \text{g} \bullet \frac{1\ \text{mol}}{129\ \text{g}} = 0.0388\ \text{mol}$$

Step 2: Calculate Molarity

$$\frac{0.0388\ \text{mol}}{0.250\ \text{L}} = 0.155\ \text{M}$$

$[NiCl_2]$ = 0.155 M

Determining Morality Mini Lab

Follow instructions exactly as written.

If asked to add 30ml of water add 30ml of water

No Pre-Lab!

Determining Morality Mini Lab

Calculate the molarities of the following solutions:

1) 2.3 moles of sodium chloride in 0.45 L of solution

2) 0.09 moles of sodium sulfate in 12mL of solution.

3) 120 g of calcium nitrite in 240mL of solution

4) 98 g of sodium hydroxide in 2.2 L of solution

Bell Work
6-April-2017

What is the molarity of a 0.4L solution made with 0.5g $CoCl_2$ at 25°C.

How do you think temperature would affect the molarity?

Using Molarity

What mass of oxalic acid, $H_2C_2O_4$, is required to make 250. mL of a 0.0500 M solution?

$$\text{moles} = \frac{\text{mol}}{\text{L}} \times \text{L}$$

Using Molarity

What mass of oxalic acid, $H_2C_2O_4$, is required to make 250. mL of a 0.05 M solution?

$$\text{moles} = \frac{\text{mol}}{\text{L}} \times \text{L}$$

Step 1: mL → L.

$$250\ \text{mL} \times \frac{1\text{L}}{1000\text{mL}} = 0.250\ \text{L}$$

Step 2: Calculate.

$$\text{Mol} = \left(\frac{0.05\ \text{mol}}{1\text{L}}\right)(0.250\ \text{L}) = 0.0125\ \text{mol}$$

Step 3: Convert moles → grams.

$$(0.0125\ \text{mol})(90.00\ \text{g/mol}) = 1.13\ \text{g}$$

Two Other Concentration Units

~~MOLALITY, *m*~~

$$\textit{m}\text{ of solution} = \frac{\text{mol solute}}{\text{kilograms solvent}}$$

% by mass

$$\%\text{ by mass} = \frac{\text{grams solute}}{\text{grams solution}} \times 100$$

Learning Check

A solution contains 15g Na_2CO_3 and 235g of H_2O. What is the mass %(m/m) of the solution?

1) **15% Na_2CO_3**
2) **6.4% Na_2CO_3**
3) **6.0% Na_2CO_3**

Bell Work
7-April-2017

What is the molar mass of $NiCl_2$?
The molar mass of the hydrate $NiCl_2 \cdot 6H_2O$?

What are the steps to make a solution from a solid and water at a given concentration using a volumetric flask?

With so many variations for representing concentrations of liquid solutions, why is it important for you to understand what each is representing

Lab Time
"Molarity Practice Lab"

First and foremost do not break the volumetric flasks!

Each person must "make" at least one of the 2 solutions

Do all the calculation before we go into lab for your chemical set

And we will not be doing a full pre lab!!!!

Lab Time
"Molarity Practice Lab"

$$\%\ \text{by m/v} = \frac{\text{g solute}}{\text{100mL solution}} \times 100$$

So… if we wanted a 100ml of 5.0%solution of $NiCl_2 \cdot 6H_2O$ we would:

Weight out: 0.05 = x / 100mL

x = 5.0g

Add 5.0g to 100ml volumetric flask and fill *to* 100ml with DI water

Lab Time
"Molarity Practice Lab"

Use the hydrate form of Copper (II) Sulfate, $CuSO_4 \cdot 5H_2O$

Disposal:

Down sink

Concentration and Stiochiometry

What volume of 0.5M Na_2CO_3 is needed to completely react with 2.0g of $HC_2H_3O_2$ in the balanced equations below?

$\underline{1}Na_2CO_3 + \underline{2}HC_2H_3O_2 \rightarrow \underline{2}NaC_2H_3O_2 + \underline{1}CO_2 + \underline{1}H_2O$

Hint: find moles of Na_2CO_3 needed using stiochiometry